Studies in the Genus Eucalyptus, Series Dumosae

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Abstract

Blakely's Series Dumosae is discussed and a hierarchy of characters, viz., stamens, cotyledons, pith glands and seed, is suggested for the definition and subdivision of the group. Seven species are recommended for exclusion and eight for inclusion on these grounds.

Introduction

The species included by Blakely (1934) in his series Dumosae are a heterogeneous group. The Series was placed in a Subsection of the Section Macrantherae based on anther and filament characters. Thirty-nine taxa were then assigned to a Series (Dumosae), the only Series of the Subsection, on the basis of their having more or less in common an assortment of other characters, viz., habit, leaf, bud and fruit morphology.

Classification based on the characters so far mentioned has led to many anomalies. While some species with atypical anthers should be excluded from the Dumosae, others should be included on anther characters and on other grounds such as cotyledon and seed morphology and the presence of pith glands. None of the latter three characters is mentioned by Blakely in his description of the Dumosae.

The importance of cotyledon morphology in classification was indicated by Pryor (1956, 1962) in reference to *Eucalyptus caesia* and *E. decipiens*. Particular attention has been recently drawn to the significance of cotyledon shape in the Dumosae by Carr and Carr (1969). All three authors suggest that cotyledon shape is of fundamental importance in eucalypt systematics and that species with bisected cotyledons should be considered as belonging to an infrageneric taxon based on this character—a scheme foreshadowed by Maiden in his "Division" Bisectae (1933). Maiden recognised two other cotyledonary types—reniform and bilobed. Eight species of Maiden's "Division" Bilobae from his Series 11 and 12, and one of his "Division" Bisectae from Series 11 were included in Blakely's Series Dumosae (1934, 1955, 1965). Blakely sometimes referred to cotyledon morphology but did not make it a basis for classification.

There is no comprehensive published work on seed morphology. Maiden (1929) composed a seed classification for about 200 species which he divided among 19 Series. The scheme, which includes five species relevant to the Dumosae, is rather obscure and incomplete despite the fact that many more species were known to him at the time. It is surprising that he did not include a description of *E. dumosa* seed as this is one of the two species of the Dumosae found in New South Wales and it might be expected that specimens of them were readily available to him. Blakely (1934) gave a slight description of the seed of species in some Series. As with many other characters of the "Key" it is not a strictly comparative treatment.

Grose and Zimmer (1958) in their work on the seed of the Victorian eucalypts were concerned mainly with descriptive morphology, and the seed of each species are dealt with in the order of Blakely's classification. There is little speculation as to the correctness of Blakely's groupings and they suggested that "species with similar seeds and chaff generally have similar types of anthers."

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They recognised the heterogeneity of seed types in Blakely's Macrantherae from which Section they discussed three species of the Dumosae, viz., *E. dumosa*, *E. incrassata* and *E. angulosa*. In their discussion of the Dumosae, they incorrectly stated that the seed of *E. incrassata* are very similar to those of *E. dumosa* (discussed later).

Gauba and Pryor (1961) were concerned mainly with seed coat anatomy. On anatomical as well as morphological grounds they considered there to be a close similarity between the seed of *E. tetraptera*, *E. erythrandra*, *E. forrestiana* and *E. stoatei*. Of these *E. stoatei* is the only one included in the Dumosae in the second and third editions of Blakely's "Key" (1955, 1965).

Carr and Carr recognised four seed categories within the Dumosae. Only one (which includes *E. dumosa*) corresponds exactly with any one of Maiden's, viz., the Series Rufispermae which Maiden based on the single species *E. woodwardii*.

It seems necessary, therefore, to reconsider Blakely's grouping of species in the Series Dumosae in the light of the additions and exclusions suggested by several workers. Varieties have not been considered and nomenclature is in accordance with Johnston and Marryatt (1965). *E. erythrandra* has been considered, although a putative hybrid, because of its importance in relating two groups of species.

Collection and Examination of Specimens

All but two or three species of the Dumosae and the related species are indigenous in Western Australia and those whose type localities are in Western Australia have been collected in that State. *E. incrassata* was collected in both Western Australia and New South Wales. *E. anceps* and *E. conglobata* which occur in both Western Australia and South Australia and whose type localities are in South Australia have been collected near Hopetoun (W.A.). *E. dumosa*, which does not occur in Western Australia, was collected in south-western New South Wales. *E. brachycalyx*, *E. erythrandra*, *E. oraria*, *E. pimpiniana* and *E. rugosa* were not seen by the author in the field and information on them has been obtained from the examination of herbarium material and from the work of Carr and Carr.

Specimens were examined particularly for stamen, cotyledon, and seed characters, and for the presence of pith glands—a character whose importance in eucalypt taxonomy was shown by Carr and Carr. Also noted but regarded as being of lesser taxonomic value were leaf, bud and fruit characters.

E. dumosa and its Allies

The first species of the Series Dumosae to be described were *E. incrassata* (1806) and *E. dumosa* and *E. angulosa* (1843). These three taxa (*E. angulosa* as *E. incrassata* var. *angulosa*) were classified by Bentham (1867) in the Series Normales, Subseries Robustae, together with *E. tetraptera*. The remainder of the species in the Subseries Robustae are quite unrelated to the Dumosae. *E. dumosa*, *E. incrassata* and *E. angulosa* were included by Blakely in his Series Dumosae and *E. tetraptera* in the Series Tetraptera. If the intention is to erect a taxon based on *E. dumosa*, it is possible to compile a list of species which are closely related to *E. dumosa* on three basic morphological grounds—features of the stamens, cotyledons and seeds.

The "dumosa" group

The anthers of *E. dumosa* are versatile, subbasifixed, moderately large, rather angular, broad, more or less truncate at the top, tapering below, opening by parallel slits. The filaments in the unopened bud are all erect, then flexed downwards and inwards radially with the anthers resting on the top of the

ovary, or with the anthers finally deflected radially outwards and then with their tops against the upper tubular part of the hypanthium. The cotyledons are reniform. The seed are fairly flat or lenticular by dorsiventral compression. The testa is red-brown, lustrous, shallowly pitted, striate with the hilum ventral, central, and not distinctly coloured.

Species which have the same characters are *E. anceps*, *E. clelandii**, *E. conglobata**, *E. dongarraensis*, *E. dumosa**, *E. kondininensis*, *E. lesouefii*, *E. pileata*, *E. sheathiana*, *E. striaticalyx**, and *E. woodwardii**.

As a group these species show no constant features of the habit, bark, leaves, peduncles, pedicels and bud morphology, which would make it easy to segregate them as a group within the Section Macrantherae. Similarly, between species these features are not always reliably contrasting, although they have been frequently used as key characters as in Bentham (1867), Ewart (1930), Blakely (1934, 1955, 1965) and Burbidge (1947). Burbidge, however, commented on the difficulties in the taxonomy of the species of the Dumosae which occur in South Australia.

The species above are centred on *E. dumosa* according to seed characters—and should comprise the Series Rufispermae which Maiden (1929) based on *E. woodwardii*. A further character which these species have in common is pith glands.

*Maiden included these species in the "Division" Bilobae. The cotyledons of the remainder were not classified by him. It is considered, however, that the cotyledons of all the species relevant to the Dumosae are better described as reniform.

The "corrugata" group

The remainder of the species of the Macrantherae which have reniform cotyledons and the staminal features of *E. dumosa* and which have pith glands have seed distinct from those of the Rufispermae. Carr and Carr place them in two seed categories. One group has seed which are "not winged, and the testa is black or dark grey with deep, sharp-edged pits". This group "centres on *E. corrugata* and includes *E. griffithsii*", To these should be added *E. comitaevallis*, *E. concinna*, *E. leptocalyx**, *E. melanoxylon*, *E. platycorys*, *E. rugosa*, *E. scyphocalyx*, and *E. torquata*. The group shows a tendency for the reduction in flower number per inflorescence from an average of seven in *E. comitaevallis* to three in *E. griffithsii* and *E. corrugata*. Specimens of *E. platycorys* may be three or seven flowered. In contrast, the inflorescences of the species of the Rufispermae are usually seven or eleven flowered, except *E. woodwardii* which may be three flowered.

The "ovularis" group

The second group of Carr and Carr is characterized by brown wingless seeds and shallow pitting of the testa and includes *E. cylindrocarpa*, *E. oraria*, and *E. ovularia*. These species show a tendency for more delicate flower parts compared with the species of the other groups. *E. dundasii* which was placed by Blakely in the Dumosae has affinity with this group in many characters. The cotyledons of this species are bilobed, however, and this character sets it apart from the Dumosae in the way the taxon is interpreted in this survey.

The ovule arrangement for the species of the three "seed" groups is similar to that of those other species in the genus which have four rows of ovules of which the basal ones and those of the outer rows except the upper ones contain embryo sacs and are presumed to be potentially fertile. The ovules at the top of the placenta and those of the inner two rows except the basal ones are non-fertile.

*Carr and Carr included *E. leptocalyx* "tentatively" in the "incrassata" seed group. The two groups are closely related and observations on more material will have to be made before *E. leptocalyx* can be correctly assigned.

The "incrassata" group

Three species of the Macrantherae, which have reniform cotyledons and the staminal features of *E. dumosa*, are not consistently glandular in the pith (Carr and Carr), viz., *E. angulosa*, *E. erythrandra*, and *E. incrassata*. However, in their external floral morphology they have affinity with *E. platycorys*, and it is reasonable to include them in the Dumosae. Their seed are considerably different from those of the "corrugata" and "ovularis" groups and even more different from those of the Rufispermae. The seed are black, circumferentially winged, more or less pyramidal with ridges ascending to the hilum which is usually whitish and distinct. These seed correspond in part to those of Series Kochioides and Series Heteroptera of Maiden (1929). The ovule arrangement of *E. incrassata* is the same as for the species of the first three groups. *E. angulosa* is variable with one or two extra rows of potentially fertile ovules. *E. erythrandra* has not been examined.

Three more species, *E. forrestiana*, *E. stoatei* and *E. tetraptera*, which are lacking in pith glands have similar seed morphology to the "incrassata" group. From the anatomy and morphology of the seed, Gauba and Pryor considered these species to be closely related to *E. erythrandra*. While the three species have affinities with the Dumosae there are grounds for considering them apart. Compared with the species of the Dumosae, the buds are large, consistently pendulous, and reduced in number to one per inflorescence. The anthers are less angular which may be due, in the larger buds, to there being less pressure of the tops of the anthers against the wall of the upper part of the hypanthium. The placentae are large with many ovules. *E. forrestiana* has 6-8 rows of ovules. *E. stoatei* and *E. tetraptera* have 8–10 rows. Only the two inner rows in each case are non-fertile. At present it is convenient to classify these species in the Dumosae whilst recognizing that they deviate in bud size, anther shape, and placental characters.

Because of morphological similarity, between *E. incrassata* and *E. platycorys* and between *E. cylindrocarpa* and *E. leptocalyx* the three latter seed categories may be inter-related.

The species relevant to this survey and their important characters are summarised in Table 1.

Discussion of species recommended for exclusion from the Dumosae

While it is suggested that seven species be excluded from the Dumosae, their true affinities are not clear in all cases. Maiden (1929) quoted C. A. Gardner as saying that *E. desmondensis* was close to *E. redunca* (Subcornutae). This is confirmed by observations on seed morphology. Both species have whitish to light grey-brown subspherical, unsculptured seed which are unique to the Series Subcornutae among the seed of Western Australian species.

E. diptera has distinctive seed and many other features in common with the gimlets and should be included with *E. salubris* in the Series Contortae. Maiden (1929) and Carr and Carr recognized the affinity of *E. diptera* with *E. salubris* and *E. campaspe*.

E. trivalva was tentatively classified as having some affinity with *E. dumosa* (Blakely 1955, 1965). The type locality is Queen Victoria Spring, Western Australia, where it is not known to have been collected since its discovery in 1891. Specimens which agree reasonably with the type description have been collected and tested from several other localities, viz., Wiluna, the Hamersley Range and the Blackstone Range in Western Australia, and the George Gill Range in the Northern Territory. The seedlings have bisected cotyledons similar to those of *E. dundasii* and consequently the specimens tested do not belong to the Dumosae. However, there must be reservations on the classification of *E. trivalva* until the species is sampled again from the type locality.

Gardner (1961) considered there was some natural affinity between *E. dongarraensis* and *E. accedens*. Collections of *E. dongarraensis* have been made

TABLE 1

Series (Blakely)	Species	Cotyledons (1)	Seeds (2)	Pith Glands (3)	Designation (4)
Tetrapterae	*tetraptera* Turcz.	reniform	4	—	included
	(5) *erythrandra* Blakely & Steedman	reniform	4	±	included
Obliquae	*woodwardii* Maiden	reniform	1	+	included
	griffithsii Maiden	reniform	2	+	included
Dumosae	*sheathiana* Maiden	reniform	1	+	retained
	(6) *accedens* W. V. Fitzg.	bisected	....	....	excluded
	desmondensis Maiden & Blakely	bisected	....	....	excluded
	loxophleba Benth.	bisected	....	....	excluded
	(7) *oraria* L. A. S. Johnson	reniform	3	+	retained
	comitae-vallis Maiden	reniform	2	+	retained
	cylindrocarpa Blakely	reniform	3	+	retained
	(8) *dundasii* Maiden	bilobed	....	....	excluded
	incrassata Labill.	reniform	4	±	retained
	(8) *scyphocalyx* (F. Muell. ex Benth.) Maiden & Blakely	reniform	2	+	retained
	diptera Andrews	bisected	....	....	excluded
	conglobata (R. Br. ex Benth.) Maiden	reniform	1	+	retained
	anceps (R. Br. ex Maiden) Blakely	reniform	1	+	retained
	dumosa A. Cunn. ex Schau.	reniform	1	+	retained
	trivalva Blakely	bisected	....	....	excluded
	leptocalyx Blakely	reniform	2	+	retained
	(5) *brachycalyx* Blakely	reniform	not avail.	+	retained
	pileata Blakely	reniform	1	+	retained
	rugosa (R. Br.) Blakely	reniform	2	+	retained
	dongarraensis Maiden & Blakely	reniform	1	+	retained
	striaticalyx W. V. Fitzg.	reniform	1	+	retained
	kondininensis Maiden & Blakely	reniform	1	+	retained
	platycorys Maiden & Blakely	reniform	2	+	retained
	concinna Maiden & Blakely	reniform	2	+	retained
	corrugata Luehm.	reniform	2	+	retained
	clelandii Maiden	reniform	1	+	retained
	lesouefii Maiden	reniform	1	+	retained
	goniantha Turcz.	bisected	....	....	excluded
	torquata Luehm.	reniform	2	+	retained
	angulosa Schau.	reniform	4	±	retained
	stoatei C. A. Gardn.	reniform	4	—	retained
Anisomelae	(5) *pimpiniana* Maiden	reniform	4	+	included
	ovularis Maiden & Blakely	reniform	3	+	included
Exsertae	*melanoxylon* Maiden	reniform	2	+	included
Quadricostatae	*forrestiana* Diels	reniform	4	—	included

which agree with the type description and with an isotype in the Western Australian Herbarium. Tests on this material show that *E. dongarraensis* has reniform cotyledons. *E. accedens* has bisected cotyledons and on this basis has no affinity with *E. dongarrensis*.

E. goniantha belongs to the Series Decurvae. Maiden (1914) recognized its relationships when he stated that this species had a close affinity with *E. falcata*.

Johnson considered that *E. loxophleba* was related to *E. oraria*. The two species have quite different cotyledons and the natural affinities of *E. loxophleba* remain undetermined.

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References

Bentham, G. (1867)—Flora Australiensis, Vol. 3 (L. Reeve & Co., London).

Blakely, W. F. (1934)—A Key to the Eucalypts. (The Worker Trustees, Sydney).

Blakely, W. F. (1955, 1965)—A Key to the Eucalypts, 2nd and 3rd Editions. (Commonw. For. Tim. Bur. Canberra).

Burbidge, Nancy T. (1947)—Key to the South Australian Species of *Eucalyptus* L'Herit. Trans. Roy. Soc. S. Austral., **71**: 137 167.

Carr, Stella, G. M. & Carr, D. J. (1969)—Oil glands and ducts in *Eucalyptus* L'Herit. I. The Phloem and the pith. Aust. J. Bot. **17**: 471–513.

Ewart, A. J. (1930)—"Flora of Victoria" (Govt. Printer, Melbourne).

Gardner, C. A. (1961)—West Aust. Dept. of Agriculture, Bull. No. 2923.

Gauba, E. & Pryor, L. D. (1961)—Seed coat anatomy and taxonomy in *Eucalyptus*. 3. Proc. Linn. Soc. New South Wales, **86**: 96–111.

Grose, R. J. & Zimmer, W. J. (1958)—A description of the seeds of 70 Victorian Eucalypts. For. Comm. Vict., Bull. No. 8.

Johnson, L. A. S. (1962)—Studies in the taxonomy of *Eucalyptus*. Contr. N.S.W. Nat. Herb. **3**: 103 126.

Johnston, R. D. & Marryatt, Rosemary (1965)—Taxonomy and nomenclature of eucalypts. Commonw. For. Tim. Bur., Canberra, Leafl. No. 92.

Maiden, J. H. (1914)—"A Critical Revision of the Genus *Eucalyptus*". Vol. 2 (Sydney).

Maiden, J. H. (1929)—"A Critical Revision of the Genus *Eucalyptus*". Vol. 7 (Sydney).

Maiden, J. H. (1933)—"A Critical Revision of the Genus *Eucalyptus*". Vol. 8 (Sydney).

Notes to Table 1.

(1) Cotyledons are classified according to Maiden's concepts (1933). A difference in interpretation has been discussed earlier.

(2) Seeds are numbered as beolnging to one of four categories as discussed above—1 refers to the "dumosa" group, 2 refers to the "corrugata" group, 3 refers to the "ovularis" group and 4 refers to the "incrassata" group.

(3) Information on pith glands is derived basically from Carr and Carr and no discrepancies were found in this survey.

(4) Species designated "retained" are those included by Blakely in the Series Dumosae which should be retained. Seven species of Blakely's Series are recommended for exclusion ("excluded") and eight others are recommended for addition ("included") to the Series.

(5) Information on *E. erythrandra*, *E. brachycalyx* and *E. pimpiniana* has been obtained from Carr and Carr

(6) The recently-described *E. laeliae* Podger and Chippendale (1969) has bisected cotyledons and is excluded along with *E. accedens* with which it has affinity.

(7) The distinction between *E. oraria* L. A. S. Johnson which has reniform cotyledons and *E. foecunda* Schau. which Maiden correctly placed in the Bisectae while apparently confusing the two taxa was clarified by Johnson (1962).

(8) Carr and Carr stated that both *E. dundasii* and *E. scyphocalyx* have bisected cotyledons. Observations show the cotyledons to be bilobed and reniform respectively.